TEST

# JEE Mains PYQs Thermal Properties of matter (Physics Master Academy)

## QUESTIONS

SECTIONS

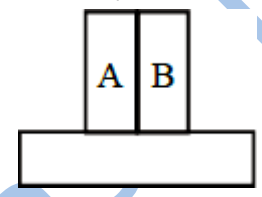
1. Section A - 25 Questions

## Section 1 : Section A - 25 Questions

SECTION INSTRUCTIONS

This section contains 25 MCQs. +4 for every correct answer, -1 for every incorrect answer.

**1** A bimetallic strip consists of metals A and B. It is mounted rigidly as shown. The metal A has higher coefkcient of expansion compared to that of metal B. When the bimetallic strip is placed in a cold bath, it will




- bend towards left
- bend towards the right
- not bend but shrink
- neither bend nor shrink

Correct: +4 · Incorrect: -1

**2** Given below are two statements: One is labeled as Assertion A and other is labeled as Reason R:
Assertion A: When a rod lying freely is heated, no thermal stress is developed in it.
Reason R: On heating, the length of the rod increases.
In the light of the above statements choose the correct answer from the options given below.

- A is true but R is false
- A is false but R is false
- Both A and R are true but R is not the correct explanation of A

- ○ Both A and R are true but R is the correct explanation of A

Correct: +4 · Incorrect: -1

**3** Each side of a box made of metal sheet in cubic shape is 'a' at room temperature 'T' the coefkcient of linear expansion of the metal sheet is 'α'. The metal sheet is heated uniformly, by a small temperature ΔT, so that its new temperature is T +ΔT. Calculate the increase in the volume of the metal box.

- ○ $3a^2\alpha\Delta T$
- ○ $4a^2\alpha\Delta T$
- ○ $3\pi a^2\alpha\Delta T$
- ○ $\frac{4}{3}\pi a^2\alpha\Delta T$

Correct: +4 · Incorrect: -1

**4** A non isotropic solid metal cube has coefkcients of linear expansion as $5\times10^{-5}$/°C along the y and the z axis. If the coefkcient of volume expansion of the solid is C × $10^{-6}$/°C then the value of C is ____

- ○ 30
- ○ 40
- ○ 50
- ○ 60

Correct: +4 · Incorrect: -1

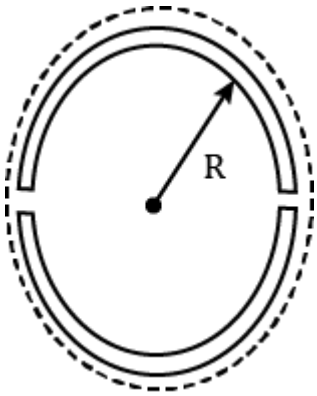
**5** The ratio of the coefkcient of volume expansion of a glass container to that of a viscous liquid kept inside the container is 1:4. What fraction of the inner volume of the container should the liquid occupy so that the volume of the remaining vacant space will be same at all temperatures?

- ○ 2:5
- ○ 1:4
- ○ 1:64
- ○ 1:8

Correct: +4 · Incorrect: -1

**6** A wooden wheel of radius R is made of two semicircular part (see kgure). The two parts are held together by a ring made of a metal strip of cross sectional area SA and length L. L is slightly less than 2πR. To kt the ring on the wheel, it is heated so that its temperature rises by ΔT and it just steps over the wheel. As it cools down to surroundings temperature, it presses the semicircular parts together. If the coefkcient of Young's modulus of linear expansion o the metal is α, and its Young's modulus is Y, the force that one part of the wheel applies on the other

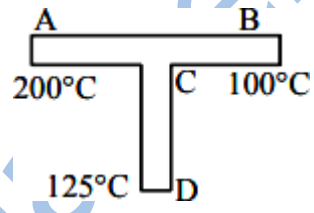
part is




- $2\pi SY\alpha\Delta T$
- $SY\alpha\Delta T$
- $\pi SY\alpha\Delta T$
- $2SY\alpha\Delta T$

Correct: +4 · Incorrect: -1

7 A rod of thermal resistance $10.0KW^{-1}$ is joined at the middle of an identical rod AB as shown in kgure. The end A, B and D are maintained at 200°C, 100°C and 125°C respectively. The heat current CD is P watt. The value of P is ___




- 1
- 2
- 3
- 4

Correct: +4 · Incorrect: -1

8 A body takes 4min to cool from 61°C to 59°C. If the temperature of the surroundings is 30°C, the time taken by the body to cool from 51°C to 49°C is

- 4 min
- 3 min
- 8 min

○ 6 min

Correct: +4 · Incorrect: -1

**9** Two identical metal wires of thermal conductivities $K_1$ and $K_2$ respectively are connected in series. The effective thermal conductivity of the combination is

○ $\frac{2K_1K_2}{K_1+K_2}$

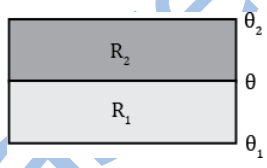
○ $\frac{2K_1K_2}{2K_1K_2}$

○ $\frac{K_1+K_2}{K_1K_2}$

○ $\frac{K_1K_2}{K_1+K_2}$

Correct: +4 · Incorrect: -1

**10** The temperature q at the junction of two insulating sheets, having thermal resistances $R_1$ and $R_2$ as well as top and bottom temperatures $q_1$ and $q_2$ (as shown in kgure) is given by




○ $\frac{\theta_1R_2-\theta_2R_1}{R_2-R_1}$

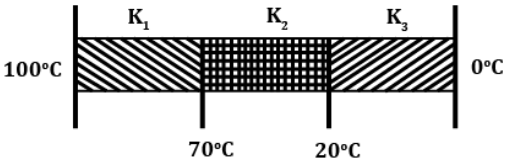
○ $\frac{\theta_2R_2-\theta_1R_1}{R_2-R_1}$

○ $\frac{\theta_1R_1+\theta_2R_2}{R_2+R_1}$

○ $\frac{\theta_1R_2+\theta_2R_1}{R_2+R_1}$

Correct: +4 · Incorrect: -1

**11** Three rods of identical cross section and lengths are made of three different materials of thermal conductivity $K_1$, $K_2$ and $K_3$ respectively. They are joined together at their ends to make a long rod (see kgure). One end of the long rod is maintained at 100°C and other at 0°C (see kgure). If the joints of the rod are 70°C and 20°C in steady state and there is no loss of energy from the surface of the rod, the correct relationship between $K_1$, $K_2$ and $K_3$ is




- $K_1:K_3 = 2:3$, $K_1<K_3 = 2:5$
- $K_1<K_2<K_3$
- $K_1:K_2 = 5:2$, $K_1:K_3 = 3:5$
- $K_1>K_2>K_3$

Correct: +4 · Incorrect: -1

**12** A bullet of mass 5g, travelling with a speed of 210m/s strikes a kxed wooden target. One half of its kinetic energy is converted into heat in the bullet while the other half is converted into heat in the wood. The rise of temperature of the bullet if the specikc heat of its material is 0.030 cal (g - °C) (1 cal = $4.2\times10^7$ ergs) close to

- 87.5°C
- 83.3°C
- 119.2°C
- 38.4°C

Correct: +4 · Incorrect: -1

**13** The specikc heat of water = 4200Jkg$^{-1}$K$^{-1}$ and the latent heat of ice = $3.4\times10^5$ Jkg$^{-1}$. 100 grams of ice at 10°C is placed in 200g of water at 25°C. The amount of ice that will melt at the temperature of water reaches 0°C is close to (in grams)

- 61.7
- 63.8
- 69.3
- 64.6

Correct: +4 · Incorrect: -1

**14** When $M_1$ gram of ice at – 10°C (specikc het = 0.5 cal g$^{-1}$°C$^{-1}$) is added to $M_2$ gram of water at 50°C, knally no ice is left and water is at 0°C. The value of latent heat of ice, in cal g$^{-1}$ is

- $\frac{50M_2}{M_1}-5$

- $\frac{5M_1}{M_2}-50$
- $\frac{50M_2}{M_1}$
- $\frac{5M_2}{M_1}-5$

Correct: +4 · Incorrect: -1

**15** A massless spring (K = 800N/m) attached with a mass (500g) is completely immersed in 1kg of water. The spring is stretched by 2cm and released so that it starts vibrating. What would be the order of magnitude of the change in the temperature of water when the vibrations stop completely? (Assume that the water container and spring rece9ive negligible heat and specikc heat of mass = 400J/kg K., specikc heat of water = 4184 J/kg K)

- K
- K
- $10^{-1}$K
- $10^{-3}$K

Correct: +4 · Incorrect: -1

**16** Ice at -20°C is added to 50g of water at 40°C. When the temperature of the mixture reaches 0°C, it is found that the 20g of ice is till unmelted. The amount of ice added to the water was close to (specikc het of water = 4.2J/g/°C; specikc heat of ice = 2.1J/g/°C; heat of fusion of water at 0°C = 334J/g)

- 50g
- 100g
- 60g
- 40g

Correct: +4 · Incorrect: -1

**17** When 100g of a liquid A at 100°C is added to 50g of a liquid B at temperature 75øC, the temperature of the mixture becomes 90°C. The temperature of the mixture, if 4100g of liquid A at 100°C is added to 50g of liquid B at 50°C will be

- 85°C
- 60°C

- ○ 80°C
- ○ 70°C

Correct: +4 · Incorrect: -1

**18** A metal ball of mass 0.1kg is heated upto 500 C and dropped into a vessel of heat capacity 800 $JK^{-1}$ and containing 0.5 kg water. The initial temperature of water and vessel is 30°C. What is the approximate percentage increment in the temperature of the water? [Specific heat capacities of water and material are respectively, 4200 $Jkg^{-1}K^{-1}$ and 400 $Jkg^{-1}K^{-1}$)

- ○ 15%
- ○ 30%
- ○ 25%
- ○ 20%

Correct: +4 · Incorrect: -1

**19** A heat source at T = $10^3$K is connected to another heat reservoir at T = $10^2$JK by a copper slab which is 1m thick. Given that the thermal conductivity of copper is 0.1 $WK^{-1}$ $m^{-1}$, the energy flux through it in the steady state is

- ○ 90 $Wm^{-2}$
- ○ 120 $Wm^{-2}$
- ○ 65 $Wm^{-2}$
- ○ 200 $Wm^{-2}$

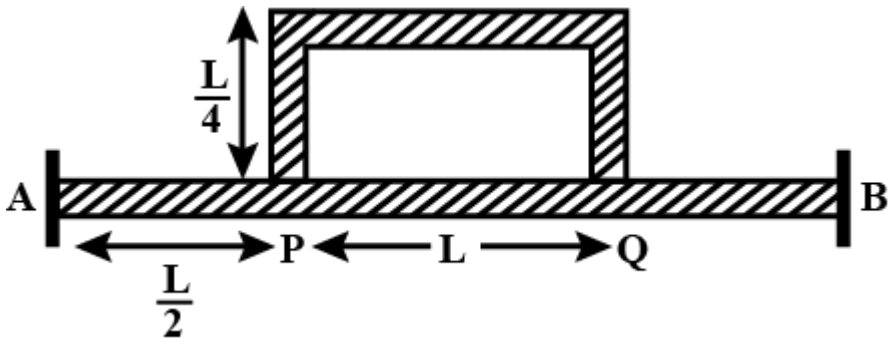
Correct: +4 · Incorrect: -1

**20** An unknown metal of mass 192g heated to a room temperature of 100°C was immersed into a brass calorimeter of mass 128g containing 240g of water at a temperature of 8.4°C. Calculate the specikc heat of unknown metal if water temperature stabilizes at 21.5°C. (specikc heat of brass is 394 $Jkg^{-1}K^{-1}$)

- ○ 458 $Jkg^{-1}K^{-1}$
- ○ 1232 $Jkg^{-1}K^{-1}$
- ○ 916 $Jkg^{-1}K^{-1}$
- ○ 654 $Jkg^{-1}K^{-1}$

Correct: +4 · Incorrect: -1

**21** Temperature of difference of 120°C is maintained between two ends of a uniform rod AB of length 2L. Another bent rod PQ, of same cross section as AB and length 3L/2, is connected across AB (see kgure). In steady state, temperature difference between P and Q will be close to




- 45°C
- 75°C
- 60°C
- 35°C

Correct: +4 · Incorrect: -1

**22** A copper ball of mass 100gm is at a temperature T. It is dropped in a copper calorimeter of mass 100gm, klled with 170gm of water at room temperature. Subsequently the temperature of the system is found to be 75°C. T is given by (Given room temperature = 30°C, specikc heat of copper = 0.1cal/gm°C)

- 1250°C
- 825°C
- 800°C
- 885°C

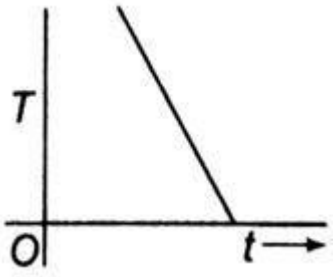
Correct: +4 · Incorrect: -1

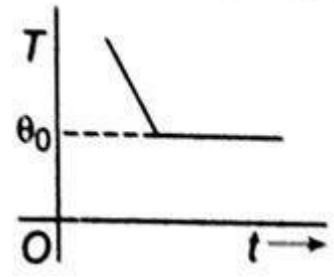
**23** In an experiment a sphere of aluminium of mass 0.20kg is heated upto 150°C. Immediately it is put into water of volume 150cc at 27°C kept in a calorimeter f oater equivalent to 0.025 kg. Final temperature of the system is 40°C. The specikc heat of aluminium is (take 4.2 Joule = 1 calorie)

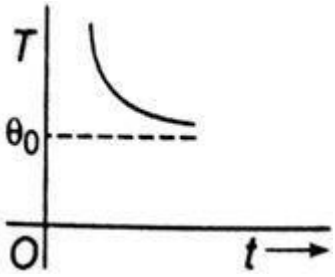
- 378 J/kg - °C
- 315 J/kg - °C
- 476 J/kg - °C
- 434 J/kg - °C

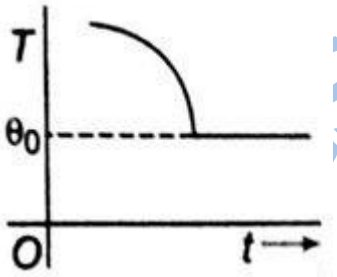
Correct: +4 · Incorrect: -1

**24** If a piece of metal is heated to temperature $\theta$ and then allowed to cool in a room which is at temperature $\theta_0$ the graph between the temperature T of the metal and time t will be closest to



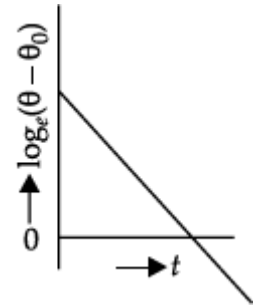



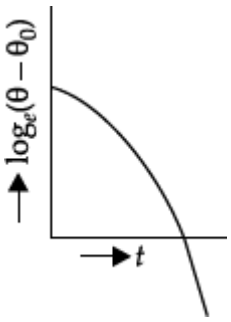



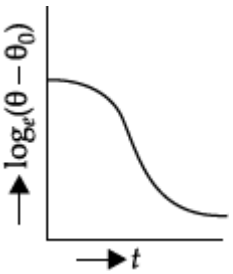



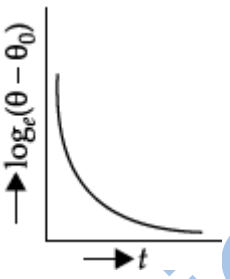

Correct: +4 · Incorrect: -1

**25** A liquid in a beaker has temperature $\theta(t)$ at time t and $\theta_0$ is temperature of surroundings, then according to Newton's law of cooling the correct graph between $\log_e(\theta\ \theta_0)$ and t is




○ 


○ 


○ 


Correct: +4 · Incorrect: -1

TEST

JEE Mains PYQs Thermal Properties of matter (Physics Master Academy)

ANSWERS

SECTIONS

1. Section A - 25 Questions

## Section 1 : Section A - 25 Questions

**1** bend towards left

**2** Both A and R are true but R is not the correct explanation of A

**3** $3a^2\alpha\Delta T$

**4** 60

**5** 1:4

**6** $2SY\alpha\Delta T$

**7** 2

**8** 8 min

**9** $\frac{2K_1K_2}{K_1+K_2}$

**10** $\frac{\theta_1R_2+\theta_2R_1}{R_2+R_1}$

**11** $K_1:K_3 = 2:3$, $K_1<K_3 = 2:5$

**12** 87.5°C

**13** 61.7

**14** $\frac{50M_2}{M_1}-5$

**15** $10^{-5}$K

**16** 40g

**17** 80°C

**18** 20%

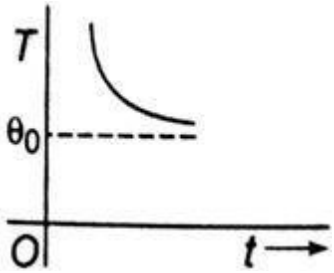
**19** 90 $Wm^{-2}$

**20** 916 $Jkg^{-1}K^{-1}$

**21** 45°C

**22** 885°C

**23** 434 J/kg - °C

24 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